Small Satellite Development

Robert S. Provence, *Johnson Space Center*
Tim Runkle, *Johnson Space Center*

NASA Johnson Space Center is sponsoring collaboration between engineering students of Texas A&M University and the University of Texas at Austin. Each university has a dedicated satellite laboratory focused on NASA's Low-earth Orbiting Navigation Experiment for Spacecraft Testing Autonomous Rendezvous (LONESTAR) project.

LONESTAR's overarching mission is to design, develop, and fly small satellites (figure 1) using only the student workforce and university laboratories, though NASA oversees the project and provides technical expertise when necessary. The ultimate goal is for small spacecraft to cooperatively perform autonomous-formation flying and docking maneuvers. To increase the likelihood of mission success, the project has four separate stages, each with its own flight, mission, and objectives.

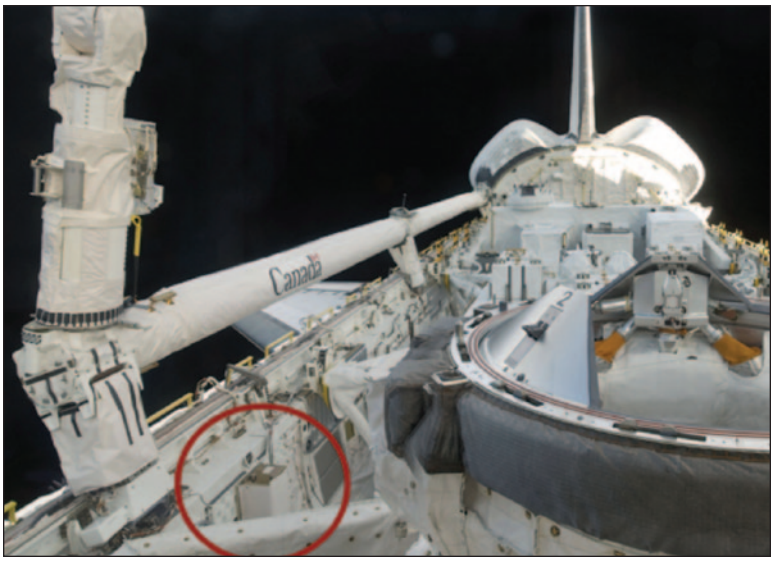

Fig. 2. *The LONESTAR satellites in Space Shuttle Picosat Launcher moments before deployment.*

The first mission's primary objective was to characterize a Global Positioning System (GPS) sensor that will be used for relative navigation in subsequent flights. The first mission also taught the students how to work as a team, and taught them the NASA process for a developmental test objective (DTO) payload.

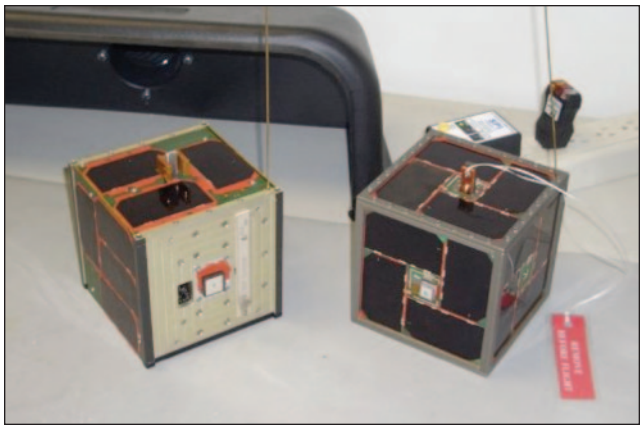

Fig. 1. *Mission 1 satellites during assembly.*

The first mission was aboard the Space Shuttle *Endeavour* during the STS-127 in the summer of 2009. Two 12.7-cm (5-in.) cube satellites were stacked and loaded into a single deployment mechanism in the payload bay (figure 2).

LONESTAR Mission 1 flew as a DTO and was deployed from Space Shuttle *Endeavour* on July 15, 2009 (figure 3).

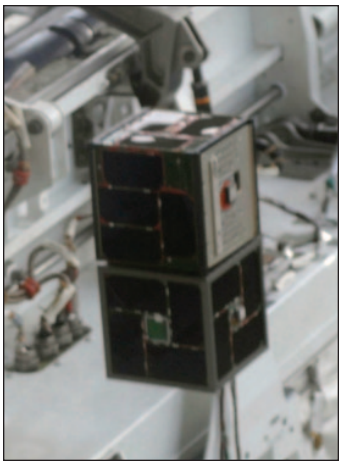

Fig. 3. *The LONESTAR satellites leaving the payload bay.*

Mission operations for this first flight lasted from deployment until March 17, 2010—just over 8 months. University students worked in their mission control centers (figure 4), first to establish a link with the satellites, then to command the satellite, and finally to download GPS data. Along with

Fig. 4. *Texas A&M University mission control center.*

the lessons learned in the development phase, the students learned to overcome real-time operational issues.

LONESTAR Mission 2 launch is scheduled for January 2013. Students are learning that the enhanced objectives of this mission are driving the physical characteristics of the satellites, which, in turn, is changing the deployment approach.

The second mission's primary objective will be to test the active attitude systems of both satellites and the thrusters on the chaser vehicle. The chaser vehicle (figure 5) will almost double in volume to accommodate the attitude and translation technology.

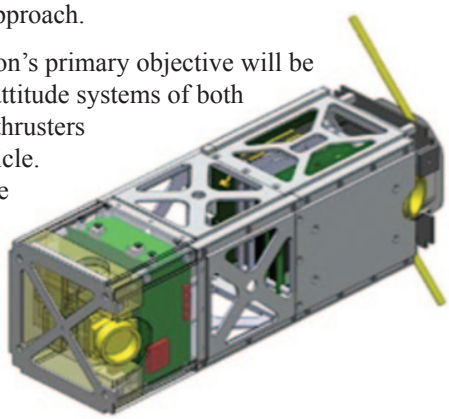

Fig. 5. *Chaser spacecraft for Mission 2.*

The target vehicle volume will be more than 100 times greater than the volume of the Mission 1 satellite. The target vehicle will house the chaser until verification and checkout of both satellites is performed. Mission Control will send the release command to deploy the chaser spacecraft that will begin relative vehicle operation.

Once the Space Shuttle Program ends, the LONESTAR project will work with the International Space Station on deployment strategies. A pressurized vehicle will transport the Mission 2 satellites to the space station, to the Japanese Experiment Module exposed facility for deployment into low-Earth orbit.

The third mission's primary objective will be to test a small satellite docking system. Since this mechanism does not yet exist, the students will be expected to design the innovative technology to allow small satellites to dock and undock, and to complete both tasks reliably.

The fourth mission's primary objective is to bring the whole system together for automated rendezvous and docking. The final test of the small satellite technology will involve a mission where both satellites perform translation maneuvers and dock autonomously.

Each incremental stage in the LONESTAR project benefits NASA by increasing the agency's knowledge of a currently emerging field where rapid development and cost-effective projects are a major focus. LONESTAR is also an educational opportunity for university students to learn about the aerospace industry under the guidance of NASA mentors, in essence developing the engineers of our future space programs.